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MEDICAL RESEARCH COMMITTEE

STATISTICAL REPORTS

No. 5.—STATISTICAL REPORTS FROM THE BRITISH FORCES IN FRANCE ON PENETRATING WOUNDS OF THE CHEST

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In close relation to the work the Medical Research Committee have undertaken for the Army Council in the compilation of the formal Medical Statistics of the War, the Committee have provided accessory help in various directions for the collection and preservation of medical records and of the after-histories of military patients, with a view both to the present guidance of medical officers and to the future purposes of the Medical History of the War. This accessory statistical work has been effected by the arrangements made for the interchange of information between separate medical units overseas and between those overseas and at home, by the schedule system of collecting information in chosen series of cases, by clerical help supplied for tracing personal histories after discharge, and in other ways. Many communications giving statistical summaries of the results of treatment in various classes of medical and surgical patients have already been published by permission in medical journals, and others have been given in several of the reports issued or published by the Committee. With the sanction of the Director-General, A.M.S., the Committee have made arrangements to issue from time to time for official distribution statistical summaries which, whether from their provisional nature or for other reasons, are not proposed for publication elsewhere.

STATISTICAL REPORTS

No. 1. 656 Cases of Gunshot Wound of the Head. (*June* 13, 1918.)

No. 2. Gunshot Wound; Compound Fracture of Femur, and Penetration of Hip and Knee Joints. (*August* 8, 1918.)

No. 3. An Analysis of 8,670 Ophthalmic Cases treated at a Home Hospital. (*January* 22, 1919.)

No. 4. 600 Cases of Gunshot Wound of the Chest. (*February* 27, 1919.)

No. 5. Statistical Reports from the British Forces in France on Penetrating Wounds of the Chest. (*June* 24, 1919.)

- I. Some Notes on Penetrating Wounds of the Chest.
- II. Statistics dealing with the Operative Treatment of Chest Wounds during the Autumn of 1917.
- III. Statistics from Base Hospitals during Autumn of 1918.
- IV. General Summary of the Statistics.

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PREFACE

The statistical report by Major W. L. Mann, C.A.M.C., has unusual value with regard to questions in the surgical treatment of chest wounds, for it traces the history of a consecutive series of such cases, a series which was begun early in 1916, when treatment was chiefly expectant, and continued during 1917 and 1918, when the older methods were replaced by the new practice of early thoracic operations. All the cases were seen and treated by Major Mann himself, who worked throughout at the same Canadian unit, which for the greater part of the time was sited at Remy Siding, Poperinghe, behind the Ypres salient. Their later history, after transference to the base and to England, was also studied by the same officer in a personal investigation of the case-sheets from home hospitals and of other available records.

The survey of the work is therefore based on a continuous personal experience, and the contrast between the results of early operation and of simple expectant treatment in each type of injury has at last been given accuracy. Further, it is right to emphasize the fact that Major Mann was recognized by all who saw his work at the Casualty Clearing Station as being a surgeon who combined judgement with technical skill in happy union, so that his practical results attained a high level of success. The record of work under these favourable conditions may fairly be accepted as a standard statement of what was achieved by a skilled surgeon in early operations on the chest.

The analyses of Colonels Soltau, Elliott, and Pasteur, on the other hand, show what were the average results of thoracic surgery as practised by all the operating surgeons of the various casualty clearing stations in an army, some of them entirely familiar with every detail of the technique that was needed for success, others less expert and less instructed in the pathological principles that should guide and control the readiness to attempt such operations. These average results were naturally below the standard achievements of specially skilled surgeons, but they do illustrate what was the actual value of the new surgery when applied throughout the forward medical services to casualties with chest wounds.

(1825.) Ps. 2305. Wt. 26395. 244/848. 11/19. O.U.P.

The two chief aims of the new development in surgery were :

1. To save life, where the wounds were so severe that without an operation the casualty would almost surely die, and die soon.

2. To check the development of empyemata or other forms of sepsis, and thus to minimize subsequent invalidism.

The complete periods of invalidism for the various injuries are shown in Major Mann's report, and figures relating to the same question have already been published in Statistical Report No. 4, by Captain Fortescue Brickdale, from a hospital in England.

The general analyses for casualty clearing stations and base hospitals in France in the latter part of this Report No. 5 give only the proportion of deaths and of empyemata that followed early operations.

MEDICAL RESEARCH COMMITTEE,
15 BUCKINGHAM STREET,
STRAND, W.C. 2.

I. SOME NOTES ON PENETRATING WOUNDS OF THE CHEST

By W. L. MANN, M.D., C.M., Manitoba, Major, C.A.M.C.,
No. 3 Canadian C.C.S.

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I. INTRODUCTION

THE following notes and observations were made on a series of over six hundred cases admitted to a front line C.C.S. (No. 3 Can.) during the period from June 1916 to November 1917 During this time the sector from which the wounded came saw periods of very active fighting and periods of comparative quiet. The series is continuous, that is to say, the cases are consecutive, and all the cases were treated by the same surgeon. All cases of chest injury, no matter what other complicating injury might be present, were admitted to the chest wards. And, so far as it is possible for us to make a diagnosis, only cases having an injury with penetration of the pleural cavity are included in the statistical part of the paper. Of course any one who has had experience with this class of case will realize that an absolutely positive diagnosis of pleural penetration is not always possible. We have tried to exclude doubtful cases, but realize fully that we are very liable to err. Also we are well aware that a classification of chest wounds into those that penetrate the pleural cavity and those that involve the chest wall only is not free from objection. Some of the most serious cases of chest injury are the so-called ‘ stove-in ’ chests. These would be ruled out in a classification based on whether or not the foreign body penetrated the pleural cavity. We do not know a classification that is free from objections, but we persist in making one because we believe the advantages of doing so are great, the objections notwithstanding. All cases of flesh wound of the chest wall are excluded from the series. That there is often some sign of lung lesion in these cases we realize. In fact, we are inclined to the belief that slight haemoptysis occurs from the contusive effects of wounds of the chest wall almost as often as from an actual penetrating wound of the chest cavity. Conversely we know that in a number of cases we have removed foreign bodies from the lung substance of patients who gave no history of haemoptysis and in whom we never saw any. We have included what we call ‘ complicated ’ chest cases. By this we mean cases having in addition to a penetrating wound of the chest either a paraplegia, a penetrating wound of the abdomen, a compound fracture of the skull, a compound fracture of the femur, or injury to the heart or some large blood-vessel. By pure chest cases we mean any chest case not having any one of the serious complications just mentioned, although it may be a case with multiple wounds, severe or otherwise. It will be apparent that a man having severe multiple wounds plus a penetrating wound of the chest may die and be classed as a fatal case of a pure chest injury, when in reality the chest injury in itself was of a comparatively slight nature and not at all likely to cause his death. But the difficulty of accurately estimating the extent to which this or that injury was the cause of death led us to adopt this arbitrary division.

These observations are necessarily very incomplete. Time and facilities for keeping cases under observation for much longer periods would, no doubt, give information of much greater value. The military necessities of the day rob us of the satisfaction of making our investigations nearly complete. It is only one stage of the wounded man’s progress we are allowed to see. Consequently our conclusions must be viewed in this light.

The patients reached the C.C.S. at times varying from one hour to ten days after being wounded. The exact time of wounding and of admission to the C.C.S. was not ascertained in all cases, but the average time between wounding and admission, where accurate record was kept, was nine hours.

The average length of stay at the C.C.S. for each patient was seven days. Cases operated on usually stayed from ten to fourteen days. Cases of infected haemothorax were kept from fifteen to thirty days according to their progress.

It is necessary also, in considering the results, to know that the treatment has not been entirely uniform. In the early months of the period the most conservative treatment was adopted. The experience gained during this time was of much value later on, when the value of operative treatment had to be considered and its results compared with the results of conservative treatment. At first a ragged parietal wound was untouched and suppurated freely in most cases. An open pneumothorax was closed by means of a gauze plug. The plug was changed at the end of the first forty-eight hours, and at the end of every twenty-four hours thereafter so long as the air leakage persisted. No attempt was made to remove a foreign body, except such as were found loose in the pleural cavity in the course of an operation for infected haemothorax. In abdomino-thoracic cases with evidence of bleeding within the abdomen or of gut injury, a laparotomy was done, but the chest was not touched. The change from this mode of treatment to that described below was gradual. First the dirty parietal wounds were taken in hand and treated by excision just as dirty wounds of any other part of the body, except that there was possibly a greater tendency to primary suture in this region. In excising parietal wounds it was often found necessary, in order to do the work thoroughly, to convert a non-leaking pleura cavity into a case of open pneumothorax during the course of the operation. If the operation was done in the first twenty-four hours no harm resulted, but to excise an actively septic wound on about the third day was found to be an unsatisfactory proceeding, and to convert the case into one of open pneumothorax during the course of such an operation was found to be disastrous. To remove the accessible F.B., repair the lung, and clean out the pleural cavity was merely an extension of the operation for pneumothorax. An open pneumothorax was always considered a much more urgent indication for operation than the removal of any F.B.

The end results reported below are far from complete. They form merely a rough indication of what happens to cases of penetrating wounds of the chest. A certain percentage of these cases have returned to duty with the Expeditionary Forces. Others are on duty in England and ultimately may return to the Expeditionary Forces or may become P.B. men, or may be discharged as permanently unfit. At present the information at hand is not sufficient to enable us to say what the permanent category of each man will be. The date of the report is in no case less than six months from time of injury. The information we have at present regarding the troops of the Overseas Dominions is even less than in the case of the Imperial troops. All we know with regard to 49 per cent. of the Australians is that they were ‘ Returned to Australia ’. We believe that many of these men so returned are eventually discharged as permanently unfit. Similarly 35 per cent. of the Canadians have been ‘ Invalided to Canada ’. How many of these go back to some form of duty and how many are discharged we are not yet able to say.

II. TREATMENT

General treatment for all cases was rest in bed in the position most comfortable for the patient. This usually was found to be the semi-sitting position, and to maintain this position Gatch bed-frames were used. Body heat was maintained by all our available means—hot-water bottles, hot air, and electric light baths. Morphia was given freely to secure rest and relieve distress. Rectal salines were given freely.

Non-Operative Treatment

The cases treated during the first six months of the period dealt with were, for the most part, treated conservatively. Later the cases treated conservatively were the cases considered too slight to need operative measures and those too severely shocked to permit of operation. Our natural tendency was always towards the conservative. We have a great deal of faith in the ability of the pleural cavity to take care of a moderate amount of infective material, and we are much impressed by the danger of operating on a chest case suffering from shock, or one in whom the respiratory compensation is not established. A large proportion (57 per cent.) of the total deaths in this series occurred in the first forty-eight hours. These were not due to infection, but due to the severity of the injury and to shock. No surgical intervention seemed to offer to do more than to hasten the end.

Operative Treatment

Cases of penetrating wound of the chest require more careful consideration and examination before being submitted to operation than any other class of wounded. There ought to be no such thing as operating on chest cases as a routine. Each case is a problem in itself. The surgical treatment of the wound is much the same as that of any other wound, i. e. thorough excision of the track, removal of the F.B., clothing, &c., and suture. But the general condition of the patient and of the other lung is of the greatest importance. A temporary cessation of function of some of the abdominal viscera is tolerated quite well, but a very brief suspension of the function of the thoracic viscera means death. If a man has much respiratory embarrassment he is not a safe risk for a general anaesthetic. If he has physical signs of ‘ something ’ in the other lung, an operation is a very real danger. The length of time occupied by an operation must be as short as possible. This may be said to be true of any operation, but it is more true in chest surgery than in any other. The size of a pleural effusion has apparently no relation to the degree of dyspnoea in the case of a chest wound. The chest is injured and the balance of the respiratory mechanism is upset, markedly at first, then a compensatory change takes place and a patient who, at the end of six hours, had extreme dyspnoea, at the end of eighteen or twenty-four hours may have no marked dyspnoea. This establishment of respiratory compensation is important in considering the advisability of operation.

The object of all operative measures is to save life, to lessen the dangers of sepsis, to reduce the period of convalescence to the minimum, and to produce the best possible functional result. What we consider to be the indications for, and the contra-indications to, operation will be apparent from our remarks on treatment. Too great emphasis cannot be laid on the importance of considering very carefully the general condition of the patient. Speed is of great importance and can only be secured by careful planning of the operation and by good team work. The accurate apposition and suture of the pleura is not often possible and apparently not of very great importance. The important thing is to get the pleural cavity quite closed off from the outer air. Drain the pleural cavity only as a last resort in a primary operation. It is advisable to aspirate the pleural cavity twenty-four to forty-eight hours after a primary thoracotomy. There is usually an effusion.

A general anaesthetic was given for most of the chest operations. The cases in poor condition were done under local anaesthesia. We have not acquired the art of giving a perfectly satisfactory local anaesthetic or it would have been used more frequently. Out of 211 cases 32 were done under local anaesthesia, and 179 under general.

III. EXPECTANT TREATMENT

Cases showing signs of a small or of no haemothorax, with no symptoms of infection, and with slight damage to the parietes, were treated expectantly, i.e. rest, morphia, heat, sitting posture, &c. Cases whose general condition was considered a contra-indication to operative measures were also treated expectantly.

End Results in Cases treated expectantly.

	%
Returned to duty	45·83
Overseas, B.E.F.	23·61
England	22·22
Returned to Australia	9·25
Invalided to Canada	5·10
Discharged as Permanently Unfit.	11·57
Pure Chests	5·50
Complicated	6·07
Died at C.C.S. (Pure Chests)	1·38
Cause of death: Pneumonia 1, Double Haemothorax 1, Haemorrhage 1.	
Died at C.C.S. (Complicated)	7·88
Chest plus Paraplegia 7, Chest plus Compound Fracture of Skull 6, Chest plus Wound of the Heart 2, Chest plus Injury of Innominate Vein 1, Chest plus Compound Fracture of Femur 1.	
Died at Base in France	1·86
Cause of death: Tetanus 1, Haemorrhage from Lung 1, Compound Fracture of Skull 1, Cause not ascertained 1.	
Died in England (2 cases of Paraplegia)	0·93
Not heard from	16·20

Total number of cases in this class, 216.

Number of months in Hospital:

Months	1	1½	2	2½	3	3½	4	4½	5	5½	6
Per cent.	5	7	14	17	12	13	7	2	3	3	4

Months	6½	7	7½	8	8½	9	9½	10 and over
Per cent.	5	2	0	0	0	1	1	4

Practically all the cases staying in hospital longer than four months did so on account of extrathoracic injuries, e.g. nerve lesions, compound fractures of the limbs, &c.

IV. ASPIRATION

Cases with signs of a moderate or a large haemothorax, with no symptoms of infection, no distress, and with only slight parietal damage were treated on general lines and by aspiration of the haemothorax, usually on the third day.

End Results in Cases Aspirated.

	%
Returned to duty	59·72
Overseas, B.E.F.	31·94
England	27·78
Returned to Australia	12·50
Invalided to Canada	4·17
Albuminuria 1, Amputation Arm 1, Double Haemothorax 1.	

	%
Discharged as Permanently Unfit	9·72
Pure Chests	6·94
F.B. embedded in Kidney, 1; Thickened Pleura, Contracted Chest, 1; Persistent Haemoptysis, 1; Chronic Purulent Bronchitis, 2.	
Complicated	2·78
Compound Femur 1, Embolus Left Leg 1.	
Died at C.C.S.	4·1
Cause of death: Haemorrhage from Subclavian Vessels 2, Haemorrhage from Lung 1.	
Died at Base in France	0·00
Died in England	0·00
Not heard from	9·72

Total number of cases in this class, 72.

Number of months in Hospital:

Months	1½	2	2½	3	3½	4	4½	5	5½
Per cent.	13·6	16	11·4	11·4	9	13·6	2·3	4·6	4·5

Months	6	6½	7	7½	8	8½	9	11
Per cent.	4·5	—	—	—	—	6·8	—	2·3

V. OPEN PNEUMOTHORAX

The percentage of cases presenting an open pneumothorax depends on the stage at which they are seen. A very great many cases showing air leakage in the first twelve hours are not leaking at the end of twenty-four hours, and still fewer are found leaking at the end of forty-eight hours. The sooner a case of open pneumothorax is converted into one that is closed the better. Nature unaided closes many of them. A pad and a layer of adhesive strapping firmly applied is all that is necessary in the slight cases. A gauze plug soaked in some antiseptic solution put into the wound down to, but not beyond, the pleura for twenty-four or forty-eight hours is quite satisfactory in some cases. We believe that this is better than a suture that merely closes over the skin. These cases should all be treated operatively as soon as conditions permit. There are many cases that for many reasons cannot be operated on immediately, but the air leakage can and should be stopped at once. Some cases where poor general condition is the contra-indication to operation can be successfully treated by the non-operative methods.

At the end of twenty or forty-eight hours the pleura has sealed over the hole in its surface and the plug may be discontinued, a pad and strapping taking its place. By the third or fourth day such a patient's general condition may be such as to permit an operation. If the wound is actively septic, don't operate. The haemothorax may be sterile in spite of the suppurating chest wall. If the haemothorax becomes infected a rib resection is done at another point and drainage provided. To introduce the discharges of an actively suppurating wound into the general pleural cavity is a vastly more serious matter than to leave introduced pieces of clothing and metal. You may get a virulent empyema in both cases, you certainly will in the former.

Examples of Cases.

Cpl. R., 2nd C.G.

Wounded about 9.30 a.m., 21.6.16. E. and E. shell wound on the posterior aspect of left chest. One wound in the left interscapular region about the level of the fifth rib, the other slightly lateral to the scapula line and on the level of the tenth interspace. Both wounds leaking air and blood freely. Subcutaneous emphysema over the left chest posteriorly. Marked dyspnoea. No haemoptysis. Complains of pain in the lower left chest in front. Temperature 99°. Pulse 132, and rather weak. X-ray showed fracture of three ribs in track of missile. The two wounds were plugged by means of gauze soaked in Dakin's solution, a gauze pad was strapped over each wound, and a roll of gauze was strapped down a line connecting the entry and exit wounds. Twenty-four hours later the plug was removed from the lower wound and about ten ounces of bloody fluid escaped. The wound was replugged. At the end of forty-eight hours both plugs were removed. There was no leakage, so the plugs were discontinued. This patient was not considered in a fit state to stand operation on the first day. He did quite well. He was evacuated to the Base on 28.6.16.

According to information received from England 17.7.16, both wounds were healed. He left hospital 9.9.16, having had no operative treatment. He has been on duty with an infantry battalion in England from that date to the present (18.2.19), category B 2, doing duty as a musketry instructor.

Case 2. Sgt. I., 31st Canadians.

Wounded 6.11.17. Shell wound right chest. Entry wound through the right pectoral muscles at level of the third rib. Exit wound in the mid line posteriorly at the level of the eighth dorsal spine. The entry wound was small and not leaking. The exit wound was about 2″ × 1½″, leaking air freely. The general condition of the patient on admission was very poor. His pulse as recorded by the nurse was 160. His respirations were 56. We considered an operation to be out of the question in his case at that time, so the leaking wound was plugged. In forty-eight hours he had improved and the wound did not leak on removal of the plug. His pulse was now 124, and respirations 44. By the third day he was fit to stand an operation. Temperature 99·6°. Pulse 96. Respirations 30. His wound was, however, quite septic, and we were afraid that if we attempted any operation we should cause air leakage through the wound again. He was evacuated to the Base on the sixth day. The return card from No. 26 General Hospital read : 'Cleared up without incident.'

From the Base Hospital in England we got the following report : 'Wounds healed. Breath sounds and percussion normal. He complains of occasional stiffness of pectoral muscles and very slight pain on sneezing and on sudden movement of the chest. No empyema developed. He left Convalescent Hospital 22.4.18, and has been on duty in England from that date till returned to Canada for demobilization, 21.12.18.'

We think that it is unwise to operate on the type of cases quoted above in the first twenty-four hours, on account of their poor general condition. As far as their general condition was concerned they could have been operated on on the third day, but our experience of cases operated on at that stage is distinctly discouraging.

Case 3. Pte. W., 13th Canadians.

Wounded 16.7.16. Bullet wound right chest. Haemoptysis. Dyspnoea. Free air leakage through wound of anterior chest wall. Subcutaneous emphysema over whole of right chest. Pain in right chest. Apex beat in fifth interspace, ½ in. outside the nipple line. Some swelling and ecchymosis in the right axilla. Appearance and general condition poor. Wound of entry small and situated just below and lateral to the inferior angle of the right scapula. Exit wound over the right second rib about the mid-clavicular line.

The anterior wound was plugged with gauze soaked in Dakin's solution. At the end of twenty-four hours there was no air leakage on removing the plug. The patient's general condition had slightly improved. This was one of our early cases and operative treatment was not considered. He was sent to the Base on the sixth day in fairly good condition.

At the Base Hospital in France he was aspirated and 25 oz. of bloody fluid withdrawn with oxygen replacement.

He was evacuated to England 31.7.16. The note on his case sheet, 30.8.16, 'Chest now quite clear. Wounds healed. Has occasional stabbing pains in the right chest.'

1.9.16. Sent to Convalescent Hospital.
31.10.16. Discharged to duty.
Service in England till sent overseas, 2.5.17.
Killed in action, 19.8.18.

Operative Treatment of Open Pneumothorax.

The operative treatment of cases of open pneumothorax consists of thorough excision of the wound in the chest wall, mopping out of the pleural cavity, and complete closure of the pleural cavity.

Examples of Cases.

Case 1. Pte. K., 17th King's Liverpool.

Bullet wound right chest and right arm. Wounded 31.7.17. Arrived at C.C.S. same date. Haemoptysis. Dyspnoea. Free air leakage through wounds of chest. No subcutaneous emphysema. Appearance pale. General condition poor. Pulse 124. E. and E. wounds of right chest. Entry in infra-scapular region. Exit in right axilla. Five ribs fractured in track of missile. Fracture of right humerus in upper third. Operation 1.8.17. Wounds of chest wall excised. Ends of broken ribs trimmed up. Pieces of loose rib removed from laceration of lung. Pleural cavity washed out with saline and closed. Wound of right arm excised. Rifle bullet removed.

This patient was sent to the Base on the fifteenth day in good condition.

29.8.17. He was evacuated to England with chest wound healed.

31.8.17. Chest wound broke down at one point. The wound was explored under anaesthesia and the empyema drained. He ran an acutely septic temperature for about fourteen days. Then a second operation was done to provide better drainage. He was out of bed in October.

21.3.18. Discharged from the service on account of right musculo-spiral paralysis.

3.6.18. Had an operation for the repair of nerve.

3.7.18. Returned to pre-war occupation as a clerk.

6.5.19. Letter from patient: 'Ribs, lung, and other parts of my chest are very little trouble, except that I have to wear a surgical belt like a pair of corsets to support me.'

Case 2. Pte. G., 10th Essex.

Wounded 11.8.17. Shell wound left chest, right shoulder, and right hand. No haemoptysis. Marked dyspnoea. Air leakage through wound. Subcutaneous emphysema of left chest wall. Appearance good. No abdominal signs. General condition fairly good. Temp. 100. Pulse 100.

Operation: Parietal wound of the left chest excised, bipped and closed, 11.8.17.

14.8.17. Aspiration of left pleural cavity, 40 oz. of blood-stained fluid withdrawn. This was sterile on culture.

17.8.17. Sent to the Base.
21.8.17. Evacuated to England.
17.12.17. Discharged from Convalescent Hospital to duty.
28.4.18. Proceeded overseas to B.E.F.
14.2.19. Now demobilized, category A.

Case 3. Pte. McL., 8th Seaforth Highlanders.

Wounded 22.8.17. E. and E. wound of anterior chest. Entry fifth rib (right), 1 in. external to nipple line. Exit 1 in. internal to left nipple line in the fifth interspace. Cough. Haemoptysis. Marked dyspnoea. Free air leakage through wounds. No subcutaneous emphysema. Complained of pain along the right and left costal margins. Apex beat in the fifth interspace in the nipple line. Appearance poor. No abdominal symptoms. General condition rather poor.

Operation: Wounds excised, bipped, and closed.

30.8.17. Sent to the Base.
10.9.17. Evacuated to England.
16.10.17. Sent to Convalescent Hospital.
19.11.17. Discharged to duty.

31.3.18. Proceeded overseas to B.E.F.
15.10.18. Wounded in shoulder.
10.2.19. Discharged as permanently unfit on account of G.S.W. shoulder.

Case 2. Pte. L., A.

Shell wound back. Wounded 20.9.17. Arrived at C.C.S. same date. Haemoptysis. Dyspnoea. Free air leakage through wounds. No subcutaneous emphysema. General condition poor. Pulse 100, weak. Entry and exit wound. Entry over one scapula, exit over the other. The skin over track of missile bellies in and out with the respirations. Right haemothorax. Patient has also some difficulty in micturition.

On admission the patient was not considered fit for operation, so the wounds were plugged and a pad strapped firmly over the track of the missile. On 22.9.17, the air leakage still persisted on removal of the plugs. The patient's condition was much improved, so he was taken to the theatre and the wound slit open from entry to exit. The track was excised, the comminuted ribs trimmed up, and the haemothorax evacuated. The rib damage and the penetration of the pleural cavity was on the right side only. After thorough excision of the track of the missile the pleural cavity was closed with difficulty by means of a muscle flap.

The right chest was aspirated subsequently and the culture from the fluid obtained grew a staphylococcus.

The patient was sent to the Base on the twelfth day in good general condition.

Report from the 5th Southern General Hospital, Portsmouth, 5.10.17: 'Treatment expectant. Except for some diminished air entry and slight signs of lung compression, convalescent and is up.'

2.7.18. This man is now on duty with the R.A.F. His category is B 2.

End Results in Open Pneumothorax Cases.

	Operation.	*No operation.*	*Totals.*
	%	%	%
Returned to duty	27·46	19·64	22·09
Overseas to B.E.F.	9·80	8·03	8·54
England	17·66	11·61	13·55
Returned to Australia	9·80	4·46	6·14
Invalided to Canada	1·96	1·79	1·84
Discharged as Permanently Unfit	15·68	15·18	15·34
On account of Chest Wounds	7·84	10·72	9·81
On account of other Wounds	7·84	4·46	5·53
Died at C.C.S.	41·18	52·69	49·08
Pure Chests	9·80	20·55	17·18
Complicated	31·38	32·14	31·90
Chest plus Pen. Wound Abdomen, 30; Chest plus Compound Fracture of Skull, 4; Chest plus Paraplegia, 6; Chest plus Compound Fracture of Femur, 2; Chest plus Shell Gas, 2; Chest plus Pen. Wound of Heart, 2; Chest plus Injury Large Vessels, 2; Chest plus Injury Oesophagus, 1; Chest plus Gas Gangrene Thigh, 3.			
Died at Base in France	0·00	0·89	0·61
Died in England	3·92	0·00	1·23
2 Cases: Under Anaesthetic 1, Pyaemia 1.			
Not heard from	0·00	5·35	3·67
Total number of cases in this class	51	112	163

Number of months in Hospital	1	1½	2	2½	3	3½	4	4½	5
	%	%	%	%	%	%	%	%	%
Operation	—	4·76	4·76	9·52	19·05	9·52	14·29	9·52	9·52
No operation	5·41	2·7	—	10·81	2·7	18·92	5·41	8·1	5·41
All Cases	3·45	3·45	1·72	10·34	8·62	15·51	8·62	8·62	6·90

Number of months in Hospital	5½	6	6½	7	8	9	10½	12
	%	%	%	%	%	%	%	%
Operation	—	9·53	4·76	—	4·76	—	—	—
No Operation	8·1	5·41	8·11	5·41	2·7	5·41	2·7	2·7
All Cases	5·17	6·9	6·9	3·45	3·45	3·45	1·73	1·73

Cases developing Septic Haemothorax . . . 23·53 33·04 30·06

VI. STOVE-IN CHESTS

This is a term applied to an injury where there is no actual penetration of the pleural cavity but where there is a severe contusion of the chest wall with simple fracture and pushing in of a number of ribs. These cases are all serious. General treatment was all that was carried out by us. Many of the cases did very badly. We have not operated on these cases, and consequently cannot express any opinion as to the value of operation other than to say that the results of conservative treatment are bad in the severe cases.

VII. INFECTED HAEMOTHORAX.

We strongly believe that exploratory puncture should be done as a routine in all cases of haemothorax, and not once merely but several times. The sooner the presence of infection is detected and treated, the better the prognosis. We do not consider it wise to wait for clinical signs and symptoms of infection before doing an exploratory needling, nor do we consider it wise to wait for bacteriological evidence, in presence of clinical signs, before commencing treatment. If a man yields a positive culture on exploratory needling, but he has neither signs nor symptoms of infection, we aspirate the pleural cavity as dry as possible and get another culture. If he is still clinically negative, we keep the pleural cavity as dry as we can by aspiration and wait. If he has doubtful clinical evidence we resect, wash out, mop out and close the pleural cavity. If a patient presents clinical evidence of infection with a sterile culture from his haemothorax we resect, clean out the pleural cavity and close. Where the pleural fluid yields a growth and the clinical signs are negative possibly the organism is non-virulent or perhaps a contamination.

The great majority of haemothorax cases yielding a growth on culture were submitted to operation, but some few in whom the clinical picture did not indicate a toxic state were treated by repeated aspiration. This was not done where streptococci were the infecting organisms, except where both pleural cavities were penetrated by the missile and where both contained an infected haemothorax. Then one side was operated on and the other was treated by repeated aspiration and injection of an antiseptic.

Examples of Cases.

Case 1. Pte. 1/6th Manchesters.

Wounded 9.9.17. Shell wounds multiple plus left chest. Three small penetrating wounds of the left infra-scapular region. Left haemothorax. Admitted same date as wounded. Temperature 108°. Pulse 120. Respirations 40. On the third day he was aspirated. The culture grew a short bacillus.

Temperature 103°. Pulse 108. Respirations 30. He was aspirated again on the sixth day and a cocco-bacillus was reported in the culture. Temperature 101°. Pulse 96. Respirations 24. He was aspirated again on the ninth day and the culture yielded a similar growth. Temperature 99°. Pulse 104. Respirations 26. He was evacuated to the Base on the eleventh day.

At the Base no further aspiration was found necessary.

24.10.17. He was evacuated to England.

30.11.17. He was discharged from hospital to Command Dépôt, having had no operative treatment after leaving the C.C.S.

Later he was categorized B 3 on account of stiffness in his left shoulder, and he was sent to his reserve unit. He was there five weeks and was categorized B 2.

6.8.18. Letter from patient: 'Nothing except ordinary dressing was done to my chest wounds in any of the hospitals. Nearly all the places I have been to they have worked on my shoulder. They have not bothered with my chest at all. I cannot get my arm level with my shoulder. I am feeling quite well up to now.'

Case 2. Pte. C., 1/6th Manchesters.

Shell wound left chest. Wounded 14.9.17. Entry left scapular region. Left haemothorax. Admitted same day as wounded. Left haemothorax aspirated 15.9.17. Culture grew a large bacillus. Aspiration left chest 17.9.17. Culture sterile. Aspiration left chest 18.9.17. Culture grew cocci. Temperature normal. Pulse 92. Respirations 28.

14.9.18. This man has been on duty as a signaller in England for several months. He is in good health and has not reported sick.

One cannot exclude the possibility of contamination in these cases, but we quote them for what they are worth.

Case 3. Pte. P., 7th Rifle Brigade.

Shell wound chest. Wounded 25.8.17. Arrived at C.C.S. 28.8.17. Haemoptysis. Dyspnoea. Air leakage through wound. Large left haemothorax. Small right haemothorax. Apex beat not definitely located. Entry wound second left interspace in nipple line. X-ray shows F.B. lying in the right chest at the level of the ninth dorsal spine and slightly internal to the nipple line.

30.8.17. Aspiration left chest. Streptococci and gas-producing anaerobes reported in the culture. Left pleural cavity drained. Entry wound explored. Track of missile found to lead towards right chest, passing in front of the pericardium but deep to the sternum. Anterior surface of the sternum smooth, posterior surface grooved. Left pleural cavity irrigated by means of Carrel-Dakin tubes.

15.9.17. Sudden rise of temperature to 103. Pulse 118. Right pleural cavity aspirated, stinking blood obtained. Ten c.c. of 2 per cent. formalin in glycerine injected. Gas-forming anaerobes and streptococci reported in culture of fluid from right chest.

16.9.17. Aspiration of right chest. Four ounces only obtained. On culture this showed a few bacteria in the anaerobic culture, no gas, no streptococci. Formalin in glycerine was injected at the time of aspiration.

18.9.17. Aspiration and injection of formalin in glycerine right chest. Culture in this case showed cocci and bacilli.

This patient was aspirated and injected twice more while at the C.C.S. The culture on both occasions yielded growth, but clinically the patient was much better. He was sent to the Base 26.9.17.

The after history of this case is that the man made an uneventful recovery. No drainage operation was done on the right side. The man was discharged as permanently unfit on 27.4.18. He complains of weakness in the left arm and shoulder, shortness of breath and palpitation on exertion, and an aching pain in the right chest.

Where the clinical signs indicate infection and the chest fluid is sterile to culture, and other causes for the clinical picture can be excluded, it is better to resect and clean out the pleural cavity.

It is possible that you may find partitions in the pleural cavity dividing it into compartments. In the exploratory puncture the needle may have tapped a compartment of sterile effusion, whereas the other portion of the effusion may be virulently infected.

Examples of Cases.

Case 1. Pte. B., 12th H.L.I.

Shell wound back. Entry right infra-scapular region. Right haemothorax. The exploring needle was put in the right chest in two places and bloody effusion withdrawn from both. The sample from the front of the chest was sterile to cultures, whereas that from the back grew streptococci. 28.8.17. The right chest was drained posteriorly. The patient was sent to the Base on the fifteenth day.

The further history of this man is that he made a good recovery. He was discharged from hospital to his reserve battalion (9.1.18) and he was sent overseas to an infantry brigade, 14.5.18, and he is still there, 28.2.19.

Case 2. Gnr. E., A.F.A.

Shell wound right chest and abdomen. Entry wound in the right axilla. X-ray showed the F.B. lodged in the right lobe of the liver. Right haemothorax. The haemothorax was aspirated on the third day. The trocar was inserted in the right axilla for the aspiration. Culture from the aspirated fluid was sterile. On the fifth day an exploring needle was put into the right pleural cavity low down in the infra-axillary region and stinking blood was withdrawn.

7.9.17. Operation : the track of the wound was explored. The ninth rib was found fractured. About 2½ inches were resected and a walled-off pocket of infected haemothorax evacuated. The hole in the diaphragm was found and the F.B. removed from the liver substance, since the infected cavity freely communicated with the wound track in the liver. The whole cavity was washed out with saline and then treated with Carrel-Dakin tubes and two-hourly instillation of Dakin's solution.

The patient was sent to the Base on the eleventh day, the temperature and pulse being then down to normal.

This man was discharged from the service as permanently unfit on 11.4.18.

Letter from this patient dated 27.7.18 : He has been working at his old trade of moulding for three months. He finds it rather too hard work. He has been off work the last two weeks with recurrent sepsis in the old wound. The wound broke down on 17.7.18 and discharged pus for about one week. At the time of writing the patient said the wound was almost healed again.

8.9.18. Letter from patient : 'Wound is healed. No operation performed. Has had a little pain in the wound in the last few days.'

If, however, on opening the pleural cavity and evacuating the effusion no evidence of very gross infection is found we close the chest and aspirate in forty-eight hours.

Examples of Cases.

Case 1. Pte. M., 5th Australian Pioneers.

Shell wound right chest. Wounded, noon, 16.9.17. Arrived at C.C.S. 2.30 p.m. same day. Haemoptysis. Dyspnoea. No air leakage. No subcutaneous emphysema. Patient complaining of pain in the left axilla and in the epigastrium. No displacement of apex beat. Appearance fair. No abdominal tenderness. No rigidity. General condition fairly good. Entry wound in the right scapular region. Right haemothorax. He was aspirated on the third day and the culture was sterile. He was aspirated again three days later. This time the aerobic culture was positive. The pleural cavity was opened and the blood clot cleared out and the cavity wiped dry. The chest wall was then closed without any drainage. 26.9.17. Right chest aspirated. Sero-sanguineous fluid obtained. On culture this grew staphylococcus. 30.9.17. Right chest aspirated, but only a few c.c. were obtained. This was sterile.

1.10.17. The patient was evacuated to the Base in good condition.
11.10.17. He was evacuated to England. Wounds healed.
21.10.17. Out of bed.
24.4.18. Proceeded overseas.
29.5.18. Still overseas. B.E.F., France.

Not infrequently when resecting on the clinical indication in face of a sterile culture we have been surprised to find a stinking haemothorax, notwithstanding the fact that twenty-four hours previously there was no odour to the aspirated fluid. In such cases we drain the chest.

In all cases showing clinical or bacteriological evidence of virulent infection we have treated by drainage. We have always felt dissatisfied with this mode of treatment, but we do not know of any better way of treating the virulently infected effusions. Many of our cases were treated by simple drainage. Others had simple drainage plus irrigation of the pleural cavity every other day with saline or Dakin's solution. Others were treated by means of Carrel-Dakin tubes put into the pleural cavity.

Examples of Cases.

Case. Pte. J., 10th Northumberland Fusiliers.

Shell wound right chest. Haemoptysis. Marked dyspnoea. No air leakage. No subcutaneous emphysema. Apex beat in the fifth interspace in the nipple line. Appearance fair. No abdominal symptoms. Entry wound third right interspace 1 in. external to the nipple line. Right haemothorax. Wounded 20.9.17. Arrived C.C.S. same date. 22.9.17. Right chest aspirated. Culture positive. 23.9.17. Rib resected. Pleural cavity washed out and closed. 1.10.17. Patient was sent to the Base in good condition.

Record Office: This man was transferred to A.S.C. 24.4.18.

22.7.18. Report from his M.O.: 'This man is doing light duty. He is tolerably well and has not reported sick.'

End Results, Infected Haemothorax Cases.

	%
Returned to duty:	15·2
Overseas to B.E.F.	1·6
England	13·6
Returned to Australia	14·4
Invalided to Canada	9·6
Discharged as Permanently Unfit:	28·0
On account of Chest Condition	24·8
On account of other Conditions	3·2
Died at C.C.S.:	26·4
Pure Chests	17·6
Complicated	8·8
Chest plus Abdomen, 7; Chest plus Paraplegia, 2; Chest plus Complicated Fracture of Skull, 1; Died of Tetanus, 1.	
Died at Base in France	0·8
Died at Base in England	1·6
Not heard from	4·0

Total number of cases in this class, 125:

Aspirated only, 12; Resected and closed, 4; Resected and drained, 109.

Number of months in Hospital:

Months	1	1½	2	2½	3	3½	4	4½
Per cent.	1·37	—	1·37	1·37	12·33	4·11	6·85	9·59
Months	5	5½	6	6½	7	7½	8	8½
Per cent.	5·48	9·59	12·33	4·11	6·85	4·11	2·74	1·37
Months	9	9½	10	10½	11½	12	14	
Per cent.	1·37	1·37	1·37	8·22	1·37	1·37	1·37	

The Retained Foreign Body.

With regard to the cases of infected haemothorax it is found that 73 per cent. of the cases had F.B. retained. It is well to remember that 70 per cent. of all the cases of the series had F.B. retained. Similarly, it is found that 88 per cent. of the infected cases were wounded by rough foreign bodies and 12 per cent. by foreign bodies with smooth surface. This must be viewed in the light of the fact that 82½ per cent. of all cases were caused by rough fragments and 17½ per cent. by smooth.

Of the cases wounded by rough foreign bodies, 17·2 per cent. developed infected haemothorax while at the C.C.S.

Of the cases wounded by smooth F.B., 12·4 per cent. developed infected haemothorax while at the C.C.S.

Of all the cases showing a foreign body retained, in 10 per cent. the missile was smooth and in 90 per cent. it was rough.

Of all the cases in which the F.B. was not retained, the missile causing the wound was smooth in 39·5 per cent. and rough in 60·5 per cent.

Of the cases of infected haemothorax with retained F.B., 11 per cent. of the missiles were smooth, and 89 per cent. rough.

Of the cases of F.B. not retained giving rise to infected haemothorax, 20 per cent. were due to smooth foreign bodies, and 80 per cent. due to rough.

Of all the cases showing F.B. retained, 16 per cent. showed infected haemothorax while at C.C.S.

Of all the cases showing F.B. not retained, 21 per cent. had infected haemothorax at C.C.S.

VIII. ABDOMINO-THORACIC WOUNDS.

Certain of these cases were treated expectantly because in some an operation did not seem to be necessary in view of the nature of the injury and in others because the patient was not in a fit state to stand a serious operation. Unfortunately there were many in the latter class. Perforating bullet wounds involving the chest, the diaphragm and a solid viscus were not operated on, where entry and exit were small. Shell fragments traversing the pleural cavity and diaphragm and lodging deep in the liver were left alone. Abdomino-thoracic cases were almost all very serious, especially those involving hollow abdominal viscera. The impressionable surgeon goes through periods of great elation when he has a series of recoveries in this class of case, and he goes through periods of equally great depression when his labours end in naught in a number of such cases. But, taken all together, we think that it is in just such cases as these that thoracic surgery has been of value. Since Lockwood brought to our attention the importance of suturing the hole in the diaphragm, we feel sure that many otherwise hopeless cases have lived. The treatment adopted in these cases briefly has been: The F.B. was first localized so that the course of the wound might be ascertained as accurately as possible and from that the position of the hole in the diaphragm. Also one wished to know whether, from the position of the F.B., extensive intra-abdominal injury might be expected. And here let it be said that in no other class of operation is it more important to have your case properly 'sized up' and your operation planned out. Here you are dealing with a patient in poor condition and one who will not stand the shock of a long operation. You are going to open two of the most important cavities of the body and you are going to handle and repair the viscera in each. Therefore you must not use a moment unnecessarily. If the injury to the diaphragm is on the left side make your thoracotomy incision one that will give you the most ready access to that lesion. We have made it our practice to attack the chest first if we are going to touch it at all. First the wound of the parietes was excised freely, any comminuted ribs trimmed up and loose pieces of bone removed. Then if the hole in the diaphragm was accessible from this point, or could be made accessible by resection of an additional piece of rib, it was treated through this opening. If not, a second opening in the chest wall was made in a suitable position. The lower down the better, provided the operation is not prolonged thereby. Bleeding in the chest was then attended to. This was very rarely necessary. If our localization of the F.B. had made it seem likely that the abdominal lesion was confined to the viscera lying immediately beneath the diaphragm and could be dealt with through the hole in it or by enlarging that hole, we brought the injured viscera up through the diaphragm, repaired and replaced them. The diaphragm was then sutured. The lacerated lung was repaired, the pleural cavity wiped dry and completely closed. This type of operation is only suitable in cases where the abdominal injury is limited to the left hypochondrium, e. g. injury to the cardiac end of the stomach, or to the transverse colon, or splenic flexure. Where there was reason to believe that the intra-abdominal injury was more extensive a laparotomy was done after the thorax had been dealt with.

In case of injury to the liver and right side of the diaphragm by a bullet or small shell fragment, we do not operate. If a hollow viscus was involved in addition to the liver and right diaphragm a laparotomy was done. The chest in this case was treated conservatively, the haemothorax aspirated if of any size. If there was injury to the lung, right diaphragm, with large F.B. embedded in the liver and accessible, we did not hesitate to do a thoracotomy, remove F.B., suture the diaphragm, suture the lung, dry out the pleural cavity and close it. In cases where the hole in the right diaphragm could be brought up and attached to the chest wall this was done and the liver thus could be drained extra-pleurally.

Examples of Cases.

Case 1. Gnr. H., R.F.A.

Shell wound, left side and right arm. Wounded 10 a.m., 20.6.17. Arrived at C.C.S. same day. No haemoptysis. Slight dyspnoea. No air leakage. No subcutaneous emphysema. Apex beat not displaced. Pain in the left lower chest and left side abdomen. Appearance poor. Has vomited once. Marked abdominal tenderness and rigidity of the left side. General condition fair. Entry wound about the level of the seventh rib in the axillary line. X-ray located the F.B. in the left upper abdominal quadrant. Signs of left haemothorax. Operation 8.45 p.m., 20.6.17. The wound of entry was excised and a fractured rib exposed. A portion of this rib was resected at the site of fracture. A small bloody effusion was wiped out of the left pleural cavity, and the hole through the diaphragm found. The omentum was protruding through the hole into the chest. This was replaced and the diaphragm sutured. The pleural cavity was closed. The external wound was bipped and closed. A laparotomy was then done. There was a large quantity of bowel contents free in the abdomen. Four holes were found in the jejunum and sutured. The abdomen was closed without drainage.

This patient was retained at the C.C.S. for twenty-six days, and then sent to the Base in good condition. He developed a left-sided empyema, which was drained on the seventeenth day after wounding.

This man made a good recovery and was discharged from the service as permanently unfit on 17.11.17.

Letter from patient 2.8.18: He had no operation after leaving the C.C.S. His wounds healed in September 1917, and he was discharged in November 1917. He has been at work since March 1918 at his pre-war occupation.

Case 2. Pte. B., 16th Manchesters.

Shell wound back. Wounded midnight, 15.6.17. No haemoptysis. Some dyspnoea. Small area of subcutaneous emphysema around entry wound. Air leakage through wound. Apex beat in the fifth interspace 1 in. external to the nipple line. Complained of pain in the right infra-axillary region. Vomiting. Marked tenderness and rigidity over the right side of the abdomen. General condition fair. Entry wound 3 in. to the right of the spine in the eleventh interspace.

Operation 4 p.m., 16.6.17. X-ray showed the F.B. in the region of the right lower abdominal quadrant. The external wound was excised. The twelfth rib was found fractured in the track of the missile. The fractured ends were trimmed up and the hole in the diaphragm sutured. The pleural cavity was closed and the external wound bipped and closed. A laparotomy was then done. There was a fair amount of blood in the abdomen. There was a tear involving the posterior and inferior surfaces of the liver. There was a hole in the peritoneum in the angle of reflection on the parietal peritoneum on to the outer side of the ascending colon. No hole could be found in the extra-peritoneal portion of the ascending colon, but the F.B. had apparently passed out of the peritoneal cavity at this point. No other gut injury was found. The F.B. was not recovered. A drain was put in through the flank to the point where the hole in the mesocolon had been repaired. The abdomen was closed.

This patient made satisfactory progress, and was sent to the Base on the eleventh day.

Report from the 83rd General Hospital, Dublin: ‘Patient's condition has steadily improved since arrival. Stitches removed 28.6.17. Discharged to England 7.7.17. Doing well. Wounds healed.’

14.9.17. Discharged to duty.
6.2.18. Proceeded overseas.
3.4.18. Serving with 2/6 Manchesters, B.E.F., France.
17.4.18. Taken prisoner of war.
3.1.19. Repatriated.

Case 3. Sergt. A., 10th West Riding.

Shell wound, left chest. Wounded 21.9.17. No haemoptysis. Slight dyspnoea. Air leakage through both entry and exit wounds. No subcutaneous emphysema. Complains of pain in the left side of the abdomen. Apex beat not displaced. Appearance pale. No vomiting. Rigidity and tenderness over the left side of the abdomen, especially the upper quadrant. General condition fair. Pulse 120. Entry wound a short distance from the left costal margin over the eighth rib. Exit over the eleventh rib behind. There was a portion of omentum protruding through the posterior wound, and oozing from this wound was a bloody discharge with a marked faecal odour.

Operation 21.9.17, at 5 p.m. The track of the missile was laid open. The eighth, ninth, and eleventh ribs were found to be comminuted. The wound of the chest wall was freely excised and the ends of the comminuted ribs trimmed up. There was found to be a laceration of the diaphragm with herniation of the stomach, the large bowel, and omentum into the left pleural cavity. There were two holes in the herniated portion of the colon a short distance from the splenic flexure, from which faecal matter had escaped into the pleural cavity. The perforation of the colon was repaired. The pleural cavity and the herniated abdominal viscera were thoroughly irrigated with saline. The hernia was next reduced and the diaphragm sutured with chromic gut. The pleural cavity was closed by suturing the diaphragm to the chest wall. The external wound was bipped and closed. A rubber-tissue drain was put in the posterior part of the wound down to the diaphragm.

22.9.17. Patient very uncomfortable. Considerable distension of the abdomen. Pulse 136. Respirations 40. No vomiting. Fomentations applied to the abdomen. Continuous rectal saline.

23.9.17. Still distended and uncomfortable. Pulse 130. Respirations 38. Pituitrin 1 c.c. followed in an hour by an enema. The patient expelled flatus and felt better.

24.9.17. Much improved. Pulse 112. Respirations 32. Had pituitrin 1 c.c. and an enema. Bowels moved. General condition much better.

1.10.17. Sent to the Base in very good condition. Temperature and pulse normal. Abdomen soft. No tenderness. Posterior 2 in. of incision suppurating freely. Carrel-Dakin treatment was started on this wound.

Base card from No. 5 General Hospital, 26.10.17 : 'Carrel's treatment. Wounds healing. Result very satisfactory. Evacuated to England.'

Record Office reports that this man is now on duty in England with the 3rd West Riding Yorks.

Letter from patient 26.7.18 : He is short of breath on exertion. He has had no further operation since leaving the C.C.S. He was discharged from hospital December 18, 1917. He is now categorized A 3 (training for overseas).

Case 4. Lieut. B., 2nd Bn. A.I.F.

Admitted 6.11.17. S.W. left shoulder, left chest, left knee-joint. Wounded 5.30 a.m., 6.11.17. Arrived at C.C.S. 1 p.m. same date. Haemoptysis. Marked dyspnoea. No air leakage through wound. No subcutaneous emphysema. Complains of pain in the left lower chest. Apex beat not displaced. Appearance fair. No vomiting. Tenderness in the left hypochondrium and slight rigidity in the same region. General condition fair. X-ray of left chest and abdomen showed F.B. about 5 in. deep to skin mark near left costal margin. No other F.B. seen.

Operation. 1. Wound of the left infra-axillary region excised and explored. Track found to lead through the tenth interspace, through the pleural cavity, through the diaphragm, into the peritoneal cavity, lacerating the diaphragmatic surface of the spleen, then through the posterior parietal peritoneum, lacerating the outer border of the left kidney, and lodging in the peri-renal tissue. A portion of the eleventh rib was excised. The hole in the diaphragm was enlarged and the F.B. removed. A counter incision was made in the flank and the peri-renal tissue drained through this. The hole in the posterior parietal peritoneum was sutured. Diaphragm sutured. Pleural cavity mopped out and closed. External wound bipped and closed.

2. Penetrating wound of the left shoulder excised. F.B. removed through a counter incision.

3. Penetrating wound of the left knee-joint at upper part of outer border of patella. There was chipping of the patella. Wound excised and enlarged. F.B. removed from the joint. Bone curetted. Joint irrigated with Dakin's solution and injected with 2 per cent. formalin in glycerine. Capsule closed. External wound bipped and closed. Limb put up on a Thomas splint with slight extension.

9.11.17. General condition of patient very good. All wounds doing very well. Very little swelling in the left knee-joint and no pain. Abdomen and chest apparently doing well.

13.11.17. Patient evacuated to the Base in good condition. Wounds all clean. Some discoloration around the drainage wound in the left flank.

Record Office: 14.2.18. This officer is now on duty at the Tank Training School, Wool, Dorset.

M.O., Tank Training School: 15.2.18. 'Lieut. B. has not reported sick. If further information is desired, I will arrange for an interview, but he is at present away on week-end leave. Judging from appearances merely, I should conclude that this officer's health has improved during his comparatively short residence at this camp.'

Case 5. Gnr. G.

Wounded 9.30 a.m., 30.10.17. Arrived at C.C.S. 2 p.m., 30.10.17. Cough. No haemoptysis. Dyspnoea. No air leakage through wound. No subcutaneous emphysema. Complains of pain in the left anterior chest, in the left shoulder, and in the left hypochondrium. Appearance poor. No vomiting. Tenderness in the left hypochondrium and general abdominal rigidity. General condition rather poor. Pulse 96. Wound of entry over the left tenth rib about 1 in. external to the left scapula line. X-ray shows F.B. in the left chest just below the level of the root of the lung, and at a depth of $5\frac{3}{4}$ in. from the anterior chest wall.

Operation 6 p.m., 30.10.17. External wound excised and the ends of the comminuted rib resected. The missile track was explored and found to lead into the pleural cavity, through the diaphragm into the abdomen, through the diaphragm again, and into the lower lobe of the left lung near the ligamentum latum pulmone. The upper hole in the diaphragm could not be conveniently reached from the wound of entry, so a portion of the sixth rib in the axillary region was resected. Through this the upper hole was easily reached. No gut injury could be found by exploring the abdomen from the thoracic side, so the two holes in the diaphragm were sutured. The F.B. was removed from the lung and the laceration sutured. The pleural cavity was wiped dry and closed, a small rubber-tissue drain being left in the lower external wound.

1.11.17. Left chest aspirated, but only a small amount of blood-stained fluid was obtained. This was sterile on culture.

6.11.17. Exploring needle in the left axilla failed to find any fluid.

12.11.17. Exploring needle in the left axilla and in the left posterior chest failed to find any fluid. The reason for the repeated needling in this case was the fact that the man's temperature was not subsiding as satisfactorily as we thought it should.

13.11.17. Sent to the Base.

Report from No. 7 Can. General Hospital. 23.11.17: 'Good progress. Still some discharge from wound.'

Evacuated to England 27.11.17.

18.1.18. Sent to Convalescent Hospital.

23.3.18. Discharged to duty.

5.8.18. Proceeded overseas to France.

Present location (18.2.19), B.E.F., France.

Case 6. Pte. B., S.T., 2nd Australian Pioneers.

Shell wound back. Wounded 9 a.m., 19.10.17. Arrived at C.C.S. same date. No haemoptysis. Marked dyspnoea. No air leakage. No subcutaneous emphysema. Pain in the left hypochondrium and in the left shoulder. Apex beat not displaced. Appearance poor. No vomiting. Abdominal tenderness and rigidity in the left hypochondrium. General condition rather poor. Entry wound over tenth rib in the left infra-scapular region. F.B. located by X-ray in the left pleural cavity at level of sixth interspace. Operation 19.10.17. The entry wound was excised and fractured tenth rib resected. The pleural cavity was mopped out. The missile track was found to lead through the diaphragm, through the spleen, through the diaphragm again, and F.B. was found lying free in the anterior costo-diaphragmatic recess. It was a piece of shell casing about 1 in. by $\frac{1}{2}$ in. by $\frac{1}{4}$ in. The omentum had herniated through the anterior hole in the diaphragm. The hole in the diaphragm was enlarged, and the abdominal viscera in the vicinity examined. No gut injury could be made out. The anterior hole in the diaphragm was closed. The posterior was brought up to the chest wall and sutured there after mopping out the pleural cavity. The spleen was packed. The external wound was bipped and partially closed. It should have been mentioned above that in order to get at the anterior hole in the diaphragm a portion of the sixth rib was excised. This wound was completely closed.

This patient made good progress while at the C.C.S., and was sent to the Base on the eleventh day.

Base card from No. 55 General Hospital: 'General condition good. Treatment as before. Convalescence uninterrupted. Evacuated to England 2.11.17.'

Record Office: 'This man was returned to Australia for a change, 16.3.18. C 2 Category.'

Case 7. Pte. P., 50th Bn., A.I.F.

Shell wound chest, abdomen, and groins. Wounded 8 a.m., 17.10.17. No haemoptysis. No dyspnoea. No air leakage through the wound. No subcutaneous emphysema. Pain in the right hypochondrium. Apex beat in the nipple line fifth interspace. No vomiting. Tenderness in the right hypochondrium. No abdominal rigidity. Appearance fair. Entry wound at the level of the eighth rib in the anterior axillary line. F.B. located by X-ray in the lower lobe of the right lung.

Operation 17.10.17. Chest wound excised and explored. Track found to lead into the pleural cavity, through diaphragm, through the outer surface of the liver, through the diaphragm again, and into the diaphragmatic aspect of the lower lobe of the right lung. The eighth rib was fractured in the entry wound. A portion of this rib was resected. The holes in the diaphragm were sutured. The F.B. was removed from the lung and the lung sutured. The pleural cavity was mopped out and closed.

Several other wounds of the trunk were excised, F.B.'s removed, and the wounds bipped.

This patient made good progress, and was sent to the Base on the ninth day.

Base card from 83rd General Hospital: 'Rib in left side removed and pleural cavity drained. Evacuated to England 25.11.17.'

No. 1 Australian Auxiliary Hospital, 17.4.18: 'Empyema wound still discharging slightly. Other wounds healed. Boarded C 3 Hospital Ship, 8.4.18. Dispatched to Hospital Ship for Australia.'

End Results in Abdomino-Thoracic Cases.

	Operation. %	*No operation.* %	*Total.* %
Returned to duty:	23·53	11·67	15·96
Overseas to B.E.F.	11·76	3·34	6·39
England	11·77	8·33	9·57
Returned to Australia	8·82	11·67	10·64
Invalided to Canada	—	1·67	1·06
Discharged as Permanently Unfit	14·71	8·33	10·64
Died at C.C.S.	50·00	60·00	56·38
Died at Base in France	2·94	0·00	1·06
Died in England	0	0	0
Not heard from	0·00	6·66	4·26
Total number of cases in this class	34	60	94

Number of months in Hospital:

Months	2	2½	3	3½	4	4½	5	5½	6	6½	7	7½
Per cent.	20	8	12	12	12	8	8	—	8	4	4	4

IX. PARIETAL INJURY

Cases with ragged wound of the chest wall were treated operatively as soon as the general condition of the patient would permit, provided that the wound was not actively septic. The wound was freely excised, any comminuted ribs trimmed up. This usually converted the case into one of open pneumothorax for the time being. If so, then the opportunity was taken to evacuate the haemothorax, and mop out the pleural cavity as dry as possible. The chest wall was then closed in layers. Sometimes the wound was treated with B.I.P.P. before being sutured.

Examples of Cases.

Case 1. Pte. E., E. A., 57th Bn. A.I.F.

Shell wound right chest. Wounded 26.9.17. Arrived at C.C.S. same date. E. and E. wound from top of right shoulder to level of the eleventh rib in the scapular line. Sixth and eleventh ribs fractured. Pleural cavity opened at the point of each fractured rib. Patient very collapsed on admission. 27.9.17. Operation: Track of missile laid open and freely excised. Ends of fractured ribs trimmed up. Wound bipped and closed. The patient did very well after the operation and he was sent to the Base on the sixth day.

16.10.17. 1st Southern General Hospital, Stourbridge. 'The wounds are soundly healed. No sign of chest mischief present. Has some cough.'

5.11.17. Discharged from hospital.

11.1.18. Returned to Australia, category C 2.

End Results, Parietal Wound Operations.	%
Returned to duty:	45·71
Overseas to B.E.F.	21·43
England	24·28
Returned to Australia	12·86
Invalided to Canada	8·57
Discharged as Permanently Unfit	14·29
On account of Chest Condition	4·29
On account of other Conditions	10·00
Died at C.C.S.:	11·43
Pure Chests	2·86
Complicated	8·57
Died at Base in France	1·43
Died in England	0·00
Not heard from	5·71
Total number in this class	70

Number of months in Hospital:

Months	1	1½	2	2½	3	3½	4
Per cent.	2·25	4·5	2·25	10·0	13·5	2·25	18·0
Months	4½	5	6	7½	9	10	10½
Per cent.	4·5	6·75	11·25	6·75	4·5	2·25	6·75

X. REMOVAL OF FOREIGN BODY

Up to the time of leaving the C.C.S. we were not very keen to operate on a chest case merely for removal of the F.B. Where we have removed the F.B. there was usually some other indication which led us to open the chest, and the removal of the F.B. was merely an incident in the operation. No one at that time was in a position to tell us very definitely what the ultimate results were in cases with retained F.B. The F.B. embedded in the lung did very little harm, so far as we could tell while the patients were with us. We have seen no bad results from operation for removal of the F.B. when that was the only indication for the operation, but then, as we have already stated, that was seldom the indication in our cases.

Among the cases traced to their return to duty only one case had trouble attributable to the retained F.B.

Examples of Cases.

Case 1. Gnr. P., R.G.A.

Shell wound back. Wounded 25.9.17 at 8 a.m. Arrived at C.C.S. the same day. No haemoptysis. Slight dyspnoea. No air leakage. No subcutaneous emphysema. Complains of pain along the right costal margin. Apex beat in the nipple line, in the fifth interspace. Appearance fair. No abdominal signs.

Signs of right pneumothorax. General condition fairly good. Pulse 100. X-ray showed the F.B. to be lodged in the posterior aspect of the lower lobe right lung. Operation 25.9.17, in the afternoon. The entry wound was at the inferior angle scapula over the eighth rib. This wound was excised and the eighth rib found to be fractured. A portion of the rib was excised at the site of the fracture. The F.B. was removed from the lung. The pleural cavity was washed out with saline and mopped dry. The pleural cavity was then closed. The external wound was bipped and closed. Twenty-eight ounces of sero-sanguineous fluid were aspirated from the right chest on the 29th. This was sterile to culture.

The patient was sent to the Base on the ninth day.

17.10.17. Evacuated to England.
24.1.18. Discharged to duty.
29.5.18. Proceeded overseas to B.E.F., France.
8.5.19. Serving with Siege Battery, France.

Case 2. Pte. P., 5th C.M.R.

Wounded 8 a.m. 30.10.17. Shell wound right chest. Arrived at C.C.S. 31.10.17. Cough. Haemoptysis. No dyspnoea. No air leakage through wound. No subcutaneous emphysema. Complains of pain in the right lower chest. Apex beat in the nipple line. General appearance good. No abdominal symptoms. General condition fair. Pulse 120. X-ray showed F.B. in the lower part of right chest.

Operation 31.10.17. External wound excised. Fractured tenth rib resected. F.B. removed from the surface of the diaphragm. Pleural cavity wiped dry and closed. External wound bipped and closed.

This patient progressed very satisfactorily after the operation and was sent to the Base on the sixth day.

30.11.17. Evacuated to England.
9.1.18. Sent to Can. Convalescent Hospital.
5.2.18. Discharged to duty.
Service in England till posted to B.E.F., France, 17.11.18.

End Results in Operations for Removal of F.B.

		%
Returned to duty:	7 or	43·75
Overseas to B.E.F.	2 or	12·50
England	5 or	31·25
Returned to Australia	3 or	18·75
Invalided to Canada	1 or	6·25
Discharged as Permanently Unfit:	4 or	25·00
On account of Chest Condition	3 or	18·75
On account of other Conditions	1 or	6·25
Died at C.C.S.:	1 or	6·25
Pure Chests	0	
Complicated	1 or	6·25
Died at Base in France	0	
Died in England	0	
Not heard from	0	
Total number in this class	16	

XI. GENERAL STATISTICS.

		%
Total number of cases in this series	631	
Pure Chest Cases		73·53
Chest plus Paraplegia		3·17
Chest plus Pen. Wound of Abdomen		14·58
Chest plus Injury to Heart or Pericardium		2·06
Chest plus Compound Fracture of the Skull		2·06
Chest plus Compound Fracture of Femur		0·79
Chest plus Injury to the Large Vessels		1·27
Chest cases with Open Pneumothorax on admission		25·83

		%
Missiles :		
With smooth surface : Bullet, Shrapnel Ball		17·43
With rough surface : Shell, Bomb, Grenade, &c.		82·41
Bayonet		0·16
Deaths :		
Total number in the series at C.C.S. :	145	22·98
Pure Chests (including those with multiple wounds)		7·45
Complicated as per explanatory note		15·53
Deaths in the first 24 hours		31·03
Deaths in the second 24 hours		26·21
Deaths after 2 days		42·76
End Results :		
Returned to Duty :		35·50
Overseas to B.E.F.		16·64
England		18·86
Returned to Australia		10·46
Invalided to Canada		5·23
Discharged as Permanently Unfit		13·94
Died at C.C.S. :		22·98
Pure Chests		7·45
Complicated		15·53
Died at Base in France		1·11
Died in England		0·95
Still in Hospital when last heard from		0·64
Not heard from		9·20

Chest Operations :		
Under local anaesthesia	32	
Under general anaesthesia	179	
Total		211
Pure Chests	152	
Complicated Chests	57	

In concluding this report I wish to express my deep sense of gratitude to Lieut.-Colonel R. J. Blanchard, O.C. No. 3 Canadian C.C.S., for his advice, assistance, and encouragement in connexion with this work and to thank him for his kind permission to publish the case reports.

I also wish to acknowledge the valuable help received in tracing the after history of the cases from Dr. Matthew Young of the Statistical Department of the Medical Research Committee and from Lieut.-Colonel J. C. Meakins, C.A.M.C.

II. STATISTICS DEALING WITH THE OPERATIVE TREATMENT OF CHEST WOUNDS DURING THE AUTUMN OF 1917

By Colonel A. B. SOLTAU and Colonel T. R. ELLIOTT,
Consulting Physicians, B.E.F.

I. Introduction.

The following figures were collected in the autumn of 1917 in order that an estimate might be made of the results of early surgical operations on cases of G.S.W. chest. At that time, surgery tended to be confined to the following classes of injury, in accordance with a memorandum from the Director-General of Medical Services, British Armies in France, which had been drawn up at a meeting of consulting physicians and surgeons.

Memorandum on the Surgical Treatment of Wounds of the Chest.

The recent attention paid to the treatment of wounds of the chest has resulted in a large number of operations, and it seems desirable to indicate the types of cases in which experience has shown that surgical procedure is indicated. It is considered that for the time being all routine operations should be confined to the following:

1. An open pneumothorax should be temporarily closed by suture at the earliest opportunity, either at the Field Ambulance or at the Casualty Clearing Station. If for any reason suturing is impossible, the wound should be packed and strapped so as to render it air-tight.
2. Extensive parietal wounds, including the above, should be treated as any other large wound. The operation should include the removal of comminuted rib fragments.
3. Where a foreign body is retained, and careful X-ray localization shows it to be accessible and of large size (not a small fragment or bullet), it may be removed, and the parietes closed after evacuation of the haemothorax.
4. Aspiration should be done in the case of any large haemothorax associated with persistent respiratory distress. This is best done after the lapse of about 48 hours.
5. Gross infections of the pleural cavity should be treated by rib resection and drainage. Where the infection is mild, it is justifiable to resect, thoroughly cleanse the cavity, and close the pleura and parietes, as secondary drainage can easily be established later if necessary.
6. Set operations, for removal of foreign bodies, &c., should not be performed until the initial collapse has passed off.
7. Whenever the thorax is opened for operation, the opportunity should be taken to close any wound of the diaphragm. This is especially important on the left side, in order to prevent subsequent hernia.
8. Where open operations have been performed the cases should be retained for 10 days after operation.

9. Reliable X-ray plant, and also immediate access to a bacteriological laboratory, are essential to successful chest survey.

The above memo., which has been drawn up after a meeting of Consulting Physicians and Surgeons on 25th inst., is forwarded for guidance and communication to Medical Units.

(Signed) W. G. Macpherson, S. G.,
for Director-General Medical Services,
British Armies in France.

G.H.Q.
2nd Echelon.
27-7-17.

The statistics, when collected, showed that early operations in such cases had given favourable results, and a brief *résumé* of them in that sense was circulated throughout the medical service in France. The actual figures, however, have not hitherto been published in detail, and this report is written in order that they may now be made accessible to any one wishing to judge more closely the results of thoracic surgery.

II. Source of the Figures.

During August, September, and October of 1917, special returns were collected from about 40 C.C.Ss. in the armies of the Ypres and Lens salients. These C.C.Ss. were heavily staffed with extra surgical teams for the fighting of the third battle of Ypres and of Paschendaele that was in progress during that autumn. The equipment of these units was fully sufficient in every way for early operations on chest wounds, and a very large proportion of such cases were treated by operation. The pressure on the accommodation in the C.C.S. was rarely so excessive that cases could not be detained a reasonable time for nursing and watching after the operation, before they were transferred to the L. of C. Hospitals at the Base.

But though the conditions at the Front were so favourable for surgery, it must on the other hand be remembered that the wounded men arrived at the C.C.S. under relatively unfavourable conditions. The proportion of casualties from shell fire to those from bullets was high, and it is known that shell wounds of the thorax are twice as fatal and at least twice as likely to cause infection as are those from bullets. Moreover, the weather most of the time was bad, and the rain and mud, with their consequent difficulties of collection and transport, caused the casualties to arrive at the C.C.S. in worse condition, and with longer delay, than had been the case in some other battles. For these reasons it is difficult to make a close comparison between the statistics from this autumn fighting and those from other occasions.

The special returns from the C.C.Ss. in the armies show the total number of all chest wounds admitted to these units. Those upon whom operation was performed are divided into several broad groups according to the nature of the operation, and the number of deaths is recorded in each group. The deaths are also given in the aggregate, but not in groups, for those which were not submitted to early operation.

The after history of the survivors after transference to the Base was not directly ascertained. Instead of tracing the cases individually, a comparative method was employed. Most of the cases went to the Boulogne and Étaples Bases. During a three-month period, namely, September, October, and November 1917, which commenced a month later than that chosen for the Front units, so as to allow for the transference to the Base of cases operated on at the C.C.S., returns were collected from all the hospitals in the Boulogne and Étaples Bases, stating the subsequent history at the Bases of all cases with G.S.W. chest that had been admitted to those hospitals *after operation at the C.C.S.* The after histories were rendered until all casualties so admitted during this three-month period had either been transferred to England or otherwise disposed of. No returns were made for the after history of the other cases that had not been operated upon at the C.C.S., and this side of the comparison, therefore, is lacking.

During the three-month period at the Front, 1,359 operations were performed upon a total of 3,521 chest wounds, that is on 38·5 per cent. The number of those who survived after operation and were transferred to the Base was 1,035. In the slightly later period of three months at the Base, 711 patients who had survived after thoracic operation at the C.C.S. were received at the Boulogne and Étaples Bases. The Base figures do not include exactly the same cases as those analysed for the armies ; but the two sets of figures are sufficiently close to one another in magnitude to permit of their being used for purposes of comparative analysis.

The returns from Base hospitals observed a classification of groups after operation similar to that employed at the C.C.S. Individual case sheets were not rendered, but a tabulated summary of the cases was made at each hospital. There is consequently a margin of error due to the different views held by different medical officers as to how a particular operation should be classified, and it was impossible to secure precise uniformity in this respect. The main aggregate results for all chest wounds are not influenced by this error, but it does affect the results shown for each separate group and lessens their accuracy to some extent.

III. ARMY STATISTICS.

Gunshot wounds of the chest admitted to C.C.Ss. in the First, Second, and Fifth Armies during August, September, and October 1917.

TABLE I.

Total number of cases recorded	3,521
Total died at C.C.S.	605 or 17·2 %
Total transferred to Base	2,916
Not operated upon at C.C.S.	2,162
Died at C.C.S.	281 or 13 %
Transferred to Base	1,881
Operated upon at C.C.S.	1,359
Died at C.C.S.	324 or 23·8 %
Transferred to Base	1,035

The cases that were submitted to early operation at the C.C.S. appeared under the following groupings. These groupings were concerned only with the nature of the operation performed, and they do not of necessity state the full extent of the injury inflicted by the wound.

TABLE I a.

Nature of operation at C.C.S.	*Total No. of cases.*	*Deaths at C.C.S.*	*Post-operative mortality.*
			%
1. For treatment of parietal wound only . . .	517	46[1]	8·9
2. For open pneumothorax, thoracotomy, or simple repair	168	75[2]	44·6
3. Thoracotomy and cleansing of uninfected haemothorax	116	15	13
4 a. Thoracotomy for removal of large F.B. from pleural cavity	73	12[3]	16·4
4 b. Thoracotomy for removal of F.B. from lung .	56	18	32
5 a. Thoracotomy and closure, for infected haemothorax	60[4]	18	30
5 b. Primary drainage for infected haemothorax .	168	74[5]	44
6. For open pneumothorax, combined with removal of F.B. from lung or pleural cavity .	19	8	42·1
7. For removal of F.B. and drainage of infected haemothorax	36	15[6]	41·6
8. Abdomino-thoracic operations	55	32	58
9. Other complicating wounds in addition to thoracic wounds, e. g. amputations, &c. . .	47	11	—

Explanatory Notes.

[1] Two died from spinal injuries, one from F.B. in brain, and four from multiple wounds elsewhere.

[2] One died from complicating wounds.

[3] One case had spinal injury.

[4] Twenty required subsequent drainage at C.C.S. and five of these died.

[5] One died from abdominal injury and one had both chests involved.

[6] One death from complicating wounds.

There are no figures available for a corresponding analysis of the wounds which were not operated upon. These would consist mainly of wounds at either end of the scale of severity, both those that were so slight as not to justify operation, and also those that were so severe as to render operation hopeless. The mortality percentage is therefore of little value for comparison with that of the intermediate group that was submitted to operation. The very high percentage, 44 per cent., of deaths in group 5 b of primary drainage by rib resection for empyema, as against 30 per cent. of deaths in secondary drainage after cleansing and closure of an infected haemothorax, 5 a, should probably be interpreted as evidence that the cases which were treated by primary drainage were those which had not been watched with vigilant care, and had been allowed to pass into a state of dangerous sepsis before they were dealt with. The mortality after primary drainage at the C.C.S. is usually less than this, when the cases are closely watched by medical officers with such experience as to be able to judge the right time for rib resection.

IV. BASE HOSPITAL STATISTICS.

Hospitals of the Boulogne and Étaples areas.

Ultimate disposal of all cases of G.S.W. chest admitted during September, October, and November 1917, *after operation at C.C.S.* Other cases, not submitted to operation at the Front, were not dealt with in these returns.

TABLE II.

Total number admitted to Base	711
Total deaths at Base	44 or 6·2 %

TABLE II a.

Nature of operation at C.C.S. and detailed results at Base.

A. For treatment of parietal wound only; 359 cases.

%
55 developed empyemata = 15·2
11 died = 3
268 transferred to U.K. without further operation.
36 transferred to U.K. after aspiration of fluid.
44 transferred to U.K. after rib resection and drainage.
7 deaths after rib resection and drainage.
4 deaths without further operation.

B. Thoracotomy and closure after removal of simple haemothorax, or of splintered bones, or of F.B.; 201 cases.

%
51 developed empyemata = 25·5
12 died = 6
121 transferred to U.K. without further operation.
28 transferred to U.K. after simple aspiration.
40 transferred to U.K. after rib resection and drainage.
9 deaths after rib resection and drainage.
2 deaths without further operation.
1 death, no details given.

C. Thoracotomy and closure for infected haemothorax; 35 cases.

%
16 developed empyemata = 46
5 died = 14·2
17 transferred to U.K. without further operation.
2 transferred to U.K. after simple aspiration.
11 transferred to U.K. after rib resection and drainage.
4 deaths after rib resection and drainage.
1 death without further operation.

D. Primary drainage at C.C.S. for infected haemothorax; 100 cases.

14 died = 14 %
76 transferred to U.K. without further operation.
10 transferred to U.K. after fresh drainage at lower rib.
7 deaths after fresh drainage at lower rib.
6 deaths without further operation.
1 death, no details given.

E. Abdomino-thoracic operations; 16 cases.

%
2 developed empyemata = 12·5
2 died = 12·5
14 transferred to U.K. without further operation.
1 death after rib resection and drainage.
1 death without further operation.

Infection of the haemothorax was proved to have occurred, either early or late, in 243 cases out of the total of 721 (=34 per cent.), and out of these 243 cases, 44, or 18 per cent., died at the Base.

If the cases in groups C and D where infection was recognized at the C.C.S. are excluded, there remain groups A, B, and E, in which primary operations at the C.C.S. were performed in the hope of arresting the development of empyemata. These give a total of 576 cases, with the following later results.

%
108 developed empyemata = 18·8
25 died = 4·4 on the total, or 23 % on the empyemata.

The Base Hospital returns show what proportion of the cases who had survived early operation at the C.C.S. did later develop empyemata or die at the Base. It is known that very few of the cases transferred to U.K. die at this later date, and that the proportion which develop late empyemata is also low. Therefore the two sets of returns, for Front and Base, may be combined to show with fair completeness the total of deaths and of empyemata.

TABLE III

Combined Statistics on Results of Early Operations at C.C.S.

Total cases recorded at Front . . . . = 3,521
Total operated on at C.C.S. . . . . = 1,359, with 324 deaths.
(Army figures) total transferred to any base after operation at C.C.S. . . . . = 1,035
(Base figures) total received at two Bases after operation at C.C.S. . . . . = 711

Nature of operation at C.C.S.	*Total cases.*	*Total deaths.*	*Total empyemata.*	*Mortality percentage in empyemata.*
Treatment of parietal wound only		%	%	%
Analysed at Front (= 1. Table I a) .	517	46 = 8·9	?	?
Analysed at Base (= A. Table II a) .	359	11 = 3	55 = 15·2	20
Total percentage of deaths and empyemata	—	11·5	+ 15·2	—
Early thoracotomy for prophylactic cleansing .				
Analysed at Front (= 3, 4 a, 4 b, & 6)	264	53 = 20	?	?
Analysed at Base (= B) . . .	201	12 = 6	51 = 25·5	24
Total percentage of deaths and empyemata	—	24·8	+ 25·5	
Thoracotomy for septic haemothorax and closure				
Analysed at Front (= 5 a) . . .	60	18 = 30	20 = 33·3	?
Analysed at Base (= C) . . .	35	5 = 14·2	16 = 46	31
Total percentage of deaths and empyemata	—	40	63	
Primary drainage for empyemata				
Analysed at Front (= 5 b and 7) . .	204	89 = 44	—	?
Analysed at Base (= D) . . .	100	14 = 14	—	—
Total percentage of deaths . . .	—	52	—	—
Abdomino-thoracic operations				
Analysed at Front (= 8) . . .	55	32 = 58	?	?
Analysed at Base (= E) . . .	16	2 = 12·5	2	—
Total percentage of deaths . . .	—	63	—	—

V. TOTAL MORTALITY IN CHEST WOUNDS

The mortality in the Regimental Aid Post has never been accurately determined by statistics. During times of heavy fighting it must depend greatly on the possibility of getting the wounded in, and doubtless a considerable proportion of those who die on the field have been mortally wounded in the chest. In quiet times many of these would reach the Aid Post and die there. From field ambulances backward, however, exact figures are available, and they gave the following results during the time under consideration.

The field ambulance mortality during August and September 1917 was 7 per cent. The death-rate in the casualty clearing station zone was 17·18 per cent., which, after deduction of the 7 per cent. who died at the field ambulance, would give 15·9 deaths on the remaining 93 cases. The death-rate at the Base was 6 per cent. on admissions, which would give 4·6 deaths on the 77 survivors from the original 100. Hence the total mortality during this autumn fighting for 100 cases reaching the first link in the chain of medical units was :

	%
At the Field Ambulance	7
At the C.C.S.	15·9
At the Base	4·6
Total	27·5

III. STATISTICS FROM BASE HOSPITALS DURING AUTUMN OF 1918, SHOWING AFTER HISTORIES OF CASES OF PENETRATING G.S.W. CHEST TRANSFERRED FROM C.C.S.

By Colonel W. PASTEUR and Colonel T. R. ELLIOTT,
Consulting Physicians, B.E.F.

I. Introduction

One year after the third battle of Ypres, figures were again collected in order to test the results of early thoracic surgery. The conditions for this surgery were now largely changed. The rapid movements forward of the fighting front imposed a corresponding mobility on the C.C.S. It was, therefore, impossible to retain wounded men for long observation and nursing care after an operation, and they were perforce sent down at a very early date to the Bases. The wide extension of the fighting over the whole front also made it difficult to concentrate surgical teams on a small sector. Both these reasons combined to lessen the number of surgical operations at the Front, and therefore fewer early operations were attempted on the chest. The difficulties of nursing patients at the C.C.S. had unfavourable results both on the operated and on the non-operated cases.

On the other hand, there were certain factors more favourable to recovery after chest wounds than in the autumn of 1917. The weather was generally good, and the men were answering to the elation of success. Collection and transport of the wounded were attended on the whole by less delay and suffering. Surgical skill and knowledge had improved with a year's further experience, and the wounds to be dealt with were less severe because the bullet now claimed a larger share than shell fragments in causing casualties.

It has been stated very emphatically by Consultants with the armies that in this open campaigning of the late summer of 1918, the military necessity of early evacuation, which reduced the number of early thoracic operations, caused far poorer results to be obtained with chests than in 1917. There are no figures yet available to show whether there was any serious increase in the number of deaths at the C.C.S.; but analyses made at the Base certainly did not give any evidence of the declared deterioration in work. Chest casualties that came down early, even on the second or third day after their wounds, and without operation, did as well as ever they had done at any time, and no harmful results of the early journey were observed. The cases that had undergone early operation did perhaps rather worse than in the previous autumn, and a larger proportion of them developed empyemata. This may have been due partly to selection of the worse cases only for operation, and partly perhaps to the difficulties of the environment under which the operations were performed.

II. Source of the Figures

A. At Boulogne an analysis was made of all penetrating wounds of the chest, excepting in officers, admitted during a four-weeks' period, from August 21 to September 18, 1918, to every hospital in that Base. A special case-sheet was rendered for each individual case, and this was sent in for analysis as soon as the case had left the hospital. A total of 548 sheets was received up to the end of October, when all the cases had been finally disposed of, either by death or transference to U.K.

Analysis of the 548 cases yielded the following figures:

Table IV

No haemothorax	95 = 17·3 %
Sterile haemothorax	400, of which 125 were estimated to contain more than 20 oz.
Septic haemothorax	53, that is 11·7 % on 453 cases of haemothorax.
Total . . .	548

Total deaths at Base, 29 = 5·2 %.
Total received without operation at C.C.S., 450.
Total received after operation at C.C.S., 98, or 18 % of total.
Empyemata at Base in non-operation group, 40, or 8·9 % (or 11·2 % if 95 cases of no haemothorax are excluded).
Empyemata at Base in operation group, 13, or 13 %.
Deaths at Base in non-operation group, 24, or 5·3 %.
Deaths at Base in operation group, 5, or 5 %.

The twenty-four deaths at the Base in cases not operated on at the Front included five cases upon whom the full operation of cleansing thoracotomy was attempted at the Base, contrary to the accepted surgical rule, at a later date from the third day onwards. All these five cases died, and this result loaded unduly the percentage of Base deaths in the group of cases not operated on at the Front.

The cases of septic haemothorax totalled 53 on the 548, and they were grouped as follows:

TABLE V

	Total.	Lived.	Died.	
C.C.S. Thoracotomy and closure .	9	6[1]	3[2]	
Base. ,, ,, ,, .	5	0	5[3]	
Front. Primary drainage . .	1	1	0	= 45 % deaths
Base. ,, ,, . .	28	15	13	
No surgical treatment . . .	8	2	6	
Septic, combined with paraplegia .	2	0	2	
Totals	53	24	29	

[1] Two cases had secondary drainage performed at Front, and three at the Base.
[2] One case had secondary drainage at the Base.
[3] One case was certainly septic before the operation.

The details of the 98 cases operated on at the C.C.S. and subsequently received at the Base were :

TABLE VI.

Operation at C.C.S.	*Total received at Base.*	*F.B. removed at C.C.S.*	*Total known empyemata.*	*Deaths at Base.*	*Drained and lived at Front.*	*Drained and lived at Base.*
Thoracotomy, cleansing, and closure	25[1]	10	7 = 28 %	3	2	2
Treatment of parietal wound and of tear in pleura	32	4	3 = 9 %	1	1	1
Simple treatment of parietal wound	41	5	3 = 7·3%	1	0	2
Totals	98	19	13 = 13 %	5	(3)	(5)

[1] Including nine abdomino-thoracic operations, of whom two died at the Base of sepsis, not having been drained.

NATURE OF MISSILE.

Certain figures with regard to the nature of the missile in these wounds are recorded here for possible value in reference.

The complete figures for the missiles in all the 453 haemothorax cases, operated and non-operated, were :

Bullet, 190, of which 15 or 7·9 % had empyemata.
Shell, 147, of which 23 or 15·6 % had empyemata.
? nature, 116, of which 15 or 13 % had empyemata.

A more detailed analysis gave the following tables, in which 'E and E' signifies a perforating or through and through wound, while 'E' represents simple penetration :

TABLE VII.

All Haemothorax Cases, 453.

	Shell.		*Bullet.*		*? Nature.*		*Total.*	
	E. & E.	*E.*	*E. & E.*	*E.*	*E. & E.*	*E.*	*E. & E.*	*E.*
Septic died . . .	3	9	6	3	6	2	15	14 = 29
Septic lived . .	0	11	5	1	3	4	8	16 = 24
Total septic . .	3	20	11	4	9	6	23	30 = 53
Total sterile haemothorax	23	101	112	63	62	39	197	203 = 400
(Large sterile haemothorax	7	33	33	21	23	8	63	62 = 125)
Totals	26	121	123	67	71	45	220	233 = 453
	147		190		116			
Percentage forming empyemata	11·5	16·6	9	6	12·6	13·4		

TABLE VIII.

Cases operated on at C.C.S., 98.

	Shell.		*Bullet.*		*? Nature.*		*Total.*	
Operation at C.C.S.	*E. & E.*	*E.*	*E. & E.*	*E.*	*E. & E.*	*E.*	*E. & E.*	*E.*
Thoracotomy . .	2	16	3	0	2	2	7	18
Pleural repair . .	5	8	6	2	7	4	18	14
Parietal wound simply .	3	8	12	9	6	3	21	20
Totals	10	32	21	11	15	9	46	52

No Haemothorax, non-operated cases, 95.

	Shell.		*Bullet.*		*? Nature.*		*Total.*	
	E. & E.	*E.*	*E. & E.*	*E.*	*E. & E.*	*E.*	*E. & E.*	*E.*
No haemothorax . .	13	13	20	13	17	19	50	45

B. From the Base at Rouen a group of records was collected under somewhat different circumstances.

During the months of June, July, August, and September 1918, records were kept in special A and D books for cases of G.S.W. chest admitted to No. 8 General Hospital (Lieutenant-Colonel S. G. Butler and Captain Beaumont), No. 10 General Hospital (Major J. B. Alexander), No. 1 Australian General Hospital (Major E. W. Fairfax), No. 12 General Hospital (Major W. Fischel, U.S.A.), and No. 11 Stationary Hospital (Major G. F. Chappel). These five hospitals were set apart as the chief centres for chest wounds admitted to the Rouen area during this period, and it is possible that for this reason they tended to receive the majority of the serious cases, while apparently trivial wounds may have gone elsewhere. Certainly, the analysis of the returns show an unusually high proportion of cases operated on at the C.C.S. At the same time it should be observed that the percentage of deaths at this Base among septic cases was remarkably low, and it is not unreasonable to ascribe this excellent result to the greater skill with which septic cases would naturally be treated at hospitals where the medical officers devoted themselves especially to the study of chest wounds. Again and again it has been the experience during this war that special attention to chest wounds by a skilled officer, whether at the C.C.S. or at the Base, can reduce the mortality in empyemata from 40 to 50 per cent. to a lower level of about 25 per cent.; and this reduction depended more on vigilant attention to the patient's progress than on the particular method of treatment employed.

The Rouen figures from these five hospitals gave the subjoined analysis:

TABLE IX.

		%
Total cases admitted from Front	1,309	
Total deaths	75, or	5·7
Total empyemata	250, or	19·1
Deaths, 70, in empyemata	28	

TABLE X.

Total cases operated on at C.C.S., 441, or 33·6 per cent. of total.

		%
	Empyemata requiring operation at Base	114 or 25
	Deaths at Base	28 or 6·2
(a)	Thoracotomy and closure (radical operation)	92
	Empyemata requiring operation at Base	26 or 28·2
	Deaths at Base	5 or 5·4
(b)	Thoracotomy and drainage	70
	Empyemata requiring further operation at Base	31 or 42·8
	Deaths at Base	4 or 5·7
(c)	Repair of parietal wall	279
	Empyemata requiring operation at Base	57 or 20·4
	Deaths at Base	19 or 6·8

(One case died under anaesthetic for secondary haemorrhage. Three cases which were bacteriologically positive, but clinically negative, are not recorded as empyemata.)

Total cases not operated on at C.C.S. = 868.

	%
Empyemata requiring operation at Base	136 or 15·6
Deaths at Base	47 or 5·4

(Five deaths in this group were not associated with empyemata.)

In the last group there were three cases, apparently all infected, which were treated by complete thoracotomy at the Base on the fifth and seventh days by Lieutenant-Colonel S. G. Butler, and all three made good recoveries.

Thoracotomy and closure were performed on eight other cases at the Base. Two of these (operation on the second day after wounding) were successful, two required reopening and draining at a later date, and four died.

As a rule the empyemata at this Base were treated by ordinary rib resection and drainage, with attentive irrigation by Carrel tubes.

Missile. The missiles recorded in 1,023 cases for the summer and autumn period were :

TABLE XI.

Shell fragments	580
Shrapnel ball	13
Bullet	423
Unknown	7
	1,023

IV. GENERAL SUMMARY OF THE STATISTICS.

The aim of this report is chiefly that of collecting such statistics as have not hitherto been published, and it is not intended to draw any formal conclusions from them upon the value of early thoracic operations or other methods of treatment.

The task that confronted the operating surgeons may be illustrated by Table No. XII, which represents approximately the results in chest wounds in the early years of the war before the acceptance of the new principles of thoracic surgery. But it must be emphasized that the table is not based upon so complete a series of returns as those which were collected later in order to test the results of surgery.

TABLE XII.

Schematic Analysis of 100 *Chest Wounds, half caused by Shell, half by Bullet.*

F.A. and C.C.S.	
25 % deaths	17 early deaths from shock, haemorrhage.
	8 deaths later from sepsis.
Base Hospitals on L. of C.	
(Percentages on admission)	4 deaths from empyemata.
6 % deaths	7 survivors from empyemata.
15 % empyemata	50 sterile haemothorax.
40 % deaths in empyemata	14 no haemothorax.
	100
Home Hospitals in England.	
Empyema cases	No deaths. Average total stay in hospital six months. 30 % invalided from army.
Sterile haemothorax cases	No deaths. Average total stay in hospital three months. 5 % invalided from army.
No haemothorax cases	No deaths. Average total stay in hospital two months. All returned to duty.

The actual results in 1917 and 1918, when operations were introduced to save life and to lessen the incidence of empyemata, appear in the next tabulated summaries (Tables XIII and XIV).

Table XIII

Table of General Results.

	1916.	1917.		1918.			
		3,520 *cases.*		*Boulogne*, 548 *cases.*		*Rouen*, 1,309 *cases* (5 *special hospitals*).	
Total mortality .	% 25 to 30 (estimated)	% 27		?		?	
Early operations at C.C.S. . . .	Nil	38		about 20		33·6	
Deaths at C.C.S. (two-thirds from shock, &c., one-third from sepsis)	?	In those operated at C.C.S., 24	In those not operated at C.C.S., 13	In those operated at C.C.S. (?)	In those not operated at C.C.S. (?)	In those operated at C.C.S. (?)	In those not operated at C.C.S. (?
Deaths at Base (all from sepsis) . .	6	6·2	?	5·0	5·3	6·2	5·4
Empyemata at Base (including deaths), percentage on admissions to Base .	15	19	?	13	8·9	25·8	15·6

TABLE XIV.

Detailed Results of Primary Operations at the Front.

		1917.	1918.
		Boulogne and Rouen.	
		%	%
Repair of thoracic wall (percentage on admissions to Base)	Deaths at C.C.S.	9	?
	Deaths at Base	3·5	5·9
	Empyemata at Base	15·5	17·9
Prophylactic thoracotomy	Deaths at C.C.S.	18·5	?
	Deaths at Base	6	6·8
	Empyemata at Base	26	28·2

These figures show that with the average skill available among general military surgeons, nearly 30 per cent. of thoracotomies developed sepsis later, and had to be drained for empyema. The general incidence of empyemata was not markedly reduced by early operations, and the great value of the new surgical procedure was seen to lie chiefly in its power to save from death men with wounds of such severity that, apart from early operation, they would unquestionably have died outright or succumbed later to an overwhelming infection of the pleura.

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